FLUORSPAR

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In the past, fluorspar was a stockpiled material considered to be vital to the Nation's national security and economy. It is used directly or indirectly to manufacture such products as aluminum, gasoline, insulating foams, refrigerants, steel, and uranium fuel. Most fluorspar consumption and trade involve either acid grade (also called acidspar), which is greater than 97% calcium fluoride (CaF_2), or subacid grade, which is 97% or less CaF_2. Subacid grade includes metallurgical and ceramic grades, and is commonly called metallurgical grade or metspar. The bulk of U.S. demand is supplied by imports, although supply is supplemented by sales of material from the National Defense Stockpile (NDS) and by small amounts of synthetic fluorspar produced from industrial waste streams. Byproduct fluorosilicic acid production from some phosphoric acid producers supplements fluorspar as a domestic source of fluorine but is not included in fluorspar production or consumption calculations. According to the U.S. Census Bureau, U.S. imports of fluorspar decreased by more than 5%, imports of hydrofluoric acid (HF) increased by nearly 3%, while exports of fluorspar increased by nearly 15% when compared with 2001.

Legislation and Government Programs

In accordance with the Strategic and Critical Materials Stock Piling Act, as amended (50 U.S.C. §98h-2), the Defense National Stockpile Center (DNSC) of the Defense Logistics Agency was authorized to sell about 54,400 metric tons (t) (60,000 short dry tons) of metallurgical-grade fluorspar and 10,900 t (12,000 short dry tons) of acid-grade fluorspar during fiscal year 2002 (October 1, 2001, to September 30, 2002). During calendar year 2002, there were no sales of fluorspar from the NDS. According to the DNSC's fiscal year 2003 (October 1, 2002, to September 30, 2003) Annual Materials Plan, total sales of about 54,400 t (60,000 short dry tons) of metallurgical grade and 10,900 t (12,000 short dry tons) of acid grade again were authorized. Unsold quantities remaining in the NDS are documented in the "Stocks" section of this report.

Production

In 2002, there was no reported mine production of fluorspar in the United States. There is no data survey for byproduct fluorspar. Domestic production data for fluorosilicic acid were developed by the U.S. Geological Survey (USGS) from voluntary surveys of U.S. operations. Of the nine fluorosilicic acid operations surveyed, eight respondents reported production, and one respondent reported zero production, representing 100% of the quantity reported.

Fluorosilicic acid is produced as byproduct from the processing of phosphate rock into phosphoric acid. In 2002, five phosphoric acid companies operated eight plants and reported production of 52,000 t of byproduct fluorosilicic acid. They sold or used 52,500 t of byproduct fluorosilicic acid (equivalent to approximately 92,500 t of fluorspar grading 92% CaF_2). This material was valued at about $8.86 million. This was an 11% decrease from the level of fluorosilicic acid output reported in 2001. Because fluorosilicic acid is a byproduct of the phosphate fertilizer industry and is not manufactured for itself alone, shortages may occur when phosphate fertilizer production decreases.

Some synthetic fluorspar was recovered as a byproduct of uranium processing, petroleum alkylation, and stainless steel pickling. The majority of the marketable product was estimated to come from uranium processing. At present [2002], an estimated 5,000 to 8,000 metric tons per year (t/yr) of synthetic fluorspar is produced in the United States.

Hastie Mining Co. washed, screened, and dried metallurgical- and acid-grade fluorspar imported or purchased from the NDS. Seaforth Mineral & Ore Co., Inc. dried and screened imported or NDS fluorspar at its facilities at Cave-In-Rock, IL, and East Liverpool, OH, as did Applied Industrial Materials Corp. at its facility at Aurora, IN.

Consumption

Domestic consumption data for fluorspar were developed by the USGS from a quarterly consumption survey of three large consumers and five distributors. Quarterly data were received from all eight respondents, and these responses make up 100% of the reported consumption in table 2.

The level of total reported fluorspar consumption increased by nearly 10% in 2002 compared with that of 2001. The majority of the increase was in consumption of acid grade for HF and aluminum fluoride (AlF_3), which combined increased by 11% to 478,000 t. Consumption of fluorspar for metallurgical uses increased by more than 18% to 76,900 t, but consumption of fluorspar for other uses, such as enamels, glass, iron and steel castings, and welding rod coatings, decreased by more than 18% to 33,300 t. The decrease in these varied markets was entirely in the consumption of acid grade, which in 2001 was 23,700 t but dropped to zero in 2002.

About 35,100 t of byproduct fluorosilicic acid valued at $5.29 million was sold for water fluoridation, and about 17,500 t valued at $3.57 million was sold or used for other uses, such as sodium silicofluoride production. There were no sales for AlF_3 production in 2002. Alcoa's AlF_3 plant at Fort Meade, FL, remained shut down and was being permanently closed.

Industry practice has established three grades of fluorspar—acid grade, containing more than 97% CaF_2; ceramic grade, containing 85% to 95% CaF_2; and metallurgical grade, containing 60% to 85% or more CaF_2. During the past several decades, there has been a general movement toward the use of higher quality fluorspar by many of the consuming industries. For example, welding rod manufacturers may use acid-grade fluorspar rather than ceramic grade, and some steel mills use ceramic or acid grade rather than metallurgical grade.

Acid grade fluorspar was used primarily as a feedstock in the manufacture of HF. Two companies reported fluorspar consumption for the production of HF—E.I. du Pont de Nemours and Co., Inc. (DuPont) and Honeywell International Inc. To analyze demand for acid-grade fluorspar it is necessary to describe and analyze the markets for HF. In 2002, the only areas of strong demand for HF were in hydrofluorocarbon (HFC) production and petroleum alkylation (driven by high refinery operating rates), although the latter only made up about 3% of the HF market.

The largest use of HF was for the production of a wide range of fluorocarbon chemicals, including HFCs, hydrochlorofluorocarbons (HCFCs), and fluoropolymers. HCFCs and HFCs were produced by the following seven companies: ATOFINA Chemicals, Inc.; DuPont; Great Lakes Chemical Corp.; Honeywell; INEOS Fluor Americas LLC; MDA Manufacturing Ltd.; and Solvay Solexis, Inc. (formerly Ausimont, Inc.).

Some of the existing or potential fluorocarbon replacements for the banned chlorofluorocarbons (CFCs) are HCFCs 22, 123, 124, 141b, 142b, and 225. These HCFC substitutes have ozone-depletion potentials that are much lower than those of CFCs 11, 12, and 113, which together had accounted for more than 90% of CFC consumption prior to their phaseout. Specific HCFCs individually or in mixtures are being used in home air conditioning systems, in chillers, as a diluent in sterilizing gas, as foam blowing agents, and as solvents (in addition to perfluorocarbons and hydrofluoroethers). However, on January 1, 2003, a ban on the production and importation of HCFC 141b went into effect. Other HCFCs also are being phased out, so the market for HCFCs will exist for only a short time, and perfluorocarbons are on the list of gases that contribute to global warming.

The HFC replacements have no ozone-depletion potential because they contain no chlorine atoms. The most successful HFC replacement compound is HFC 134a. It is the main replacement for CFC 12 in automobile air conditioners and is being used as the refrigerant in new commercial chillers and refrigerators and as the propellant in aerosols and tire inflators. HFCs 23, 32, 125, 143a, 152a, 227ea, 236fa, 245fa, and 4310 also are being produced domestically but in much smaller quantities. These HFCs are being used individually or in blends as replacements for CFCs and HCFCs.

The largest use for HCFC 141b was as a foam blowing agent; however, with the ban on its production and importation, HFCs 134a, 152a, 236ea, 245fa, 356, and 365mfc have been tested as potential replacements as blowing agents for such foams as rigid polyurethane, flexible polyurethane, and polystyrene. For blowing polyurethane, it appears that the blowing agents of choice are 134a, 245fa, and 365mfc. In 2002, Honeywell constructed a plant in the United States to manufacture HFC 245fa for the North American market. HFC 365mfc is not approved for foam blowing in the United States as yet, but Solvay Fluor (a business unit of Solvay S.A.) built a plant in France to manufacture it for the European market; production started in early 2003. HFC 152a has been approved for use in several types of foams but primarily is used for blowing polystyrene and polyolefin foams.

HCFCs 22, 123, and 124; HFCs 23, 125, 134a, and 227ea; and a number of other fluorine compounds have been approved by the U.S. Environmental Protection Agency (EPA) as acceptable substitutes (some subject to use restrictions) for halon 1211 as a streaming agent and for halon 1301 as a total flooding agent for fire suppression. With the exception of the U.S. Department of Defense, however, there has not been a significant concerted effort anywhere in the United States to remove fire control systems using halons 1211 and 1301 from service and replace them with products using alternatives. Unfortunately, the alternatives compare unfavorably (based on cost, space, and weight) when compared with halons, and there are sufficient supplies of recycled halons 1211 and 1301 available at prices reasonable enough to make it more cost effective to recharge these systems than to replace them with alternatives (Wickham, 2002§[1]). Although the production of halons has been banned in the United States since 1993, the use of recycled halon material is still permitted.

The strongest growth area for HF consumption is in the manufacture of fluoropolymers. CFC 113, HCFCs 22 and 142b, and HFC 152a were produced as chemical intermediates in the production of fluoropolymers. Fluoropolymers have desirable physical and chemical properties that allow them to be used in products from pipes and valves to architectural coatings to cookware. These intermediate uses of CFC 113 and HCFCs 22 and 142b will not be subject to the production phaseouts mandated by the Montreal Protocol on Substances that Deplete the Ozone Layer and the Clean Air Act Amendments of 1990 because these products are consumed in the manufacturing process.

HF was consumed in the manufacture of uranium tetrafluoride, which was used in the process of concentrating uranium isotope 235 for use as nuclear fuel and in fission explosives. It also was used in stainless steel pickling, petroleum alkylation, glass etching, treatment of oil and gas wells, and as a cleaner and etcher in the electronics industry. HF was used as the feedstock in the manufacture of a group of inorganic fluorine chemicals that include chlorine trifluoride, lithium fluoride, sodium fluoride, stannous fluoride, sulfur hexafluoride, tungsten hexafluoride, and others that are used in dielectrics, metallurgy, wood preservatives, mouthwashes, decay-preventing dentifrices, and water fluoridation. It is used as the feedstock for producing potassium fluoride, which is the preferred fluorine source in a number of insecticides and herbicides, as well as in some proprietary analgesic preparations, antibiotics, and antidepressants.

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[1]References that include a section mark (§) are found in the Internet References Cited section.

Acid-grade fluorspar was used in the production of AlF_3, which is the main fluorine compound used in aluminum smelting. In the Hall-Héroult aluminum process, alumina is dissolved in a bath of molten cryolite, AlF_3, and fluorspar to allow electrolytic recovery of aluminum. On average, worldwide the aluminum industry consumes about 23 kilograms of fluorides (measured as AlF_3 equivalent) for each metric ton of aluminum produced, ranging from 10 to 12 kilograms per metric ton (kg/t) in a modern prebaked aluminum smelter to 40 kg/t in an older Soderberg smelter without scrubbers. AlF_3 was added to the electrolyte in reduction cells to improve the cells' electrical efficiency. It was used by the ceramics industry for some body and glaze mixtures, in the production of specialty refractory products, and in the manufacture of aluminum silicates and in the glass industry as a filler. The AlF_3 manufactured for use in aluminum reduction cells is produced directly from acid-grade fluorspar or from byproduct fluorosilicic acid. In 2002, Alcoa World Chemicals (a business unit of Alcoa Inc.) produced AlF_3 from fluorspar at Point Comfort, TX.

Acid- or ceramic-grade fluorspar was used by the ceramic industry as a flux and an opacifier in the production of flint glass, white or opal glass, and enamels. These grades also were used in welding fluxes and as a flux in the steel industry. In welding, fluxes are commercially termed welding consumables, and are manufactured as a flux coating to electrodes, as a flux core in a wire electrode, or as powdered flux product. These products are broadly categorized as acid, basic, rutile, and cellulosic. Fluorspar is used in basic compositions where it can make up 30% to 40% of the flux composition (O'Driscoll, 2002).

Metallurgical grade fluorspar was used primarily as a fluxing agent by the steel industry. Fluorspar is added to the slag to make it more reactive by increasing its fluidity (by reducing its melting point) and thus increasing the chemical reactivity of the slag. Reducing the melting point of the slag brings lime and other fluxes into solution to allow the absorption of impurities. Fluorspar of different grades was used in the manufacture of aluminum, brick, and glass fibers and by the foundry industry in the melt shop.

Consumption of fluorspar in metallurgical markets (mainly steel) increased by 18% compared with 2001. The steel market was strengthened when, on March 5, 2002, the President imposed tariffs on various types of imported steel ranging from 8% to 30%, excluding imports from free-trade partners. The tariffs went into effect March 20, 2002, for a period of 3 years and were scheduled to decrease in each of the subsequent years (Thelen Reid & Priest LLP, 2002§). The tariffs appear to have slowed the increase in import levels. Overall imports of raw steel actually increased by 8% in 2002 when compared with 2001 (American Iron and Steel Institute, 2003§). The tariffs did provide some relief to domestic steel producers, with the result that steel production increased by 2.5% and steel prices went up, at least temporarily.

Domestic steel companies continue to fail and declare bankruptcy; there were more than 35 bankruptcies reported between 1998 and 2002. These bankruptcies have negatively affected the fluorspar distributors that supply the domestic merchant market. When a steel company declares bankruptcy, most of its debts are discharged, and the debtor is no longer required by law to pay these debts (in this case for fluorspar purchased).

Metallurgical- or sub-metallurgical-grade fluorspar is used in cement production where it acts mainly as a flux. It is added to the mix of cement raw materials before introduction to the rotary kiln. The addition of fluorspar provides a savings in thermal energy by allowing the kiln to operate at a lower temperature, thus saving fuel. It also increases the amount of tricalcium silicate produced. More tricalcium silicate results in a softer clinker product, which requires less grinding time, thus saving electrical energy.

The merchant fluorspar market includes metallurgical- and acid-grade sales to steel mills, foundries, glass and ceramics plants, welding rod manufacturers, and other small markets in rail car, truckload, and less than truckload quantities. This merchant market is mature in the United States and in 2002 amounted to about 110,000 t, about equally divided between acid- and metallurgical-grade sales. During the past 20 to 30 years, fluorspar usage in such industries as steel and glass has declined because of product substitutions or changes in industry practices.

Stocks

Data for stocks were available from distributors and HF and AlF_3 producers. Known consumer and distributor stocks totaled 245,000 t, which included 122,000 t at consumer or distributor facilities and 123,000 t purchased from the NDS but still located at NDS depots. As of December 31, 2002, the NDS fluorspar inventory classified as excess (excluding material sold pending shipment) contained about 109,000 t (120,000 short dry tons) of fluorspar (table 1). This total included about 6,770 t of acid grade (7,470 short dry tons), 89,700 t of metallurgical grade (98,900 short dry tons), and 12,600 t (13,900 short dry tons) of metallurgical grade that did not meet NDS specifications. These numbers, particularly in the breakdown between metallurgical grade and non-stockpile grade, differ from those reported in 2001, and it is assumed that the DNSC's records were updated or reassessed.

Transportation

The United States is import dependent for the majority of its fluorspar supply. Fluorspar is transported to customers by truck, rail, barge, and ship. Metallurgical grade is shipped routinely as lump or gravel, with the gravel passing a 75-millimeter (mm) sieve and not more than 10% by weight passing a 9.5-mm sieve. Acid grade is shipped routinely in the form of damp filtercake containing 7% to 10% moisture to facilitate handling and to reduce dust. Most acid-grade imports come from China and South Africa. Fluorspar is usually shipped by ocean freight using bulk carriers of 10,000 to 50,000 t deadweight. Participants negotiate freight levels, terms, and conditions.

Prices

At yearend, the average range of U.S. Gulf port prices, including cost, insurance, and freight, dry basis, for Chinese acid grade decreased to a range of $128 per metric ton to $135 per ton (table 3). South African price ranges for acid grade [free on board (f.o.b.) Durban] were unchanged, and price ranges for Mexican acid-grade fluorspar (f.o.b. Tampico) were essentially unchanged compared with those of 2001. Industrial Minerals no longer lists a price for metallurgical-grade fluorspar, so the prices listed in table 3 are derived from fourth-quarter data calculated from U.S. Census Bureau statistics.

The yearend 2002 price quotation for aqueous HF, 70%, in drums, f.o.b., freight allowed, was unchanged at $0.65 per pound. The quotation for chemically pure (99.0 weight percent) anhydrous HF, 1,300 pounds, f.o.b., was unchanged at $2.96 per pound. Quoted yearend prices for AlF_3 were unchanged and ranged from $825 per ton to $1,408 per ton. Quoted prices for sodium fluoride, white, 97%, in 50- or 100-pound bags or drums, carloads were unchanged at $0.60 per pound, f.o.b. Tampa, and $0.63 per pound, f.o.b. El Paso. A price quote for fluorosilicic acid was not available (Chemical Market Reporter, 2003).

Foreign Trade

U.S. exports of fluorspar increased by nearly 15% to 24,300 t from the 2001 figure (table 4). All U.S. exports were believed to be re-exports of material imported into the United States or exports of material purchased from the NDS.

In 2002, imports for consumption of fluorspar decreased by more than 5% when compared with those of 2001 (table 5). The largest suppliers of fluorspar to the United States, in descending order, were China, South Africa, and Mexico. China accounted for nearly 70% of U.S. fluorspar imports. The average unit value including c.i.f. was $128 per ton for acid grade and $89 per ton for metallurgical grade (table 1).

Imports of HF increased by nearly 3% to 115,000 t, or a quantity equivalent to about 172,000 t of fluorspar (table 6). Imports of synthetic and natural cryolite increased by nearly 18% to 7,950 t, or a quantity equivalent to 9,540 t of fluorspar (table 7). Imports of AlF_3 decreased slightly to 17,000 t, or a quantity equivalent to about 25,500 t of fluorspar (table 8).

There are no tariffs on fluorspar from normal-trade-relations countries. There are no tariffs on other major fluoride minerals and chemicals, such as natural or synthetic cryolite, HF, and AlF_3.

World Review

Estimated world production was essentially unchanged compared with the revised 2001 data (table 9). China, Mexico, South Africa, Mongolia, and Russia, in decreasing order, were the largest producers.

Europe.—Production in Europe was estimated to be about 372,000 t; Spain (35%) and France (28%) were the major producers. Consumption was estimated to be about 900,000 t, with major import sources being, in descending order, Africa, China, and Mexico. The European Commission of the European Union (EU) initiated a partial review of the antidumping measures on Chinese fluorspar in June. The current measures, in the form of a minimum import price, do not differentiate between sales made to related parties and sales made to unrelated parties or between first sales and successive sales. No decision has yet been released (Mineral PriceWatch, 2002).

In the EU, EC Regulation 2037/2000 prohibited the sale and use of halons 1301 and 1211 as of December 31, 2002, including material that has been recovered or recycled. Existing halon systems may be used and maintained through the end of 2003, but with the exception of equipment deemed critical under the regulation, all fire-fighting equipment in the EU containing halons must be decommissioned before December 31, 2003 (Fire Safety Advice Center, 2003§).

Australia.—Resource investment bank Mineral Securities Ltd. (MSL) announced the acquisition of the Speewah fluorite project in the East Kimberley region of northern Western Australia. The Speewah project is on the eastern edge of the Kimberley block, where the Greenvale and Liamma Faults separate Proterozoic sandstones, siltstones, and minor volcanics from the western margin of the Halls Creek mobile belt. The Greenvale Fault is a complex zone consisting of a composite system of intersecting faults, which contain fluorite veins and carbonatite dikes. According to MSL, the project has the potential to produce 150,000 t/yr of acid-grade concentrate for the export market (Mineral Securities Ltd., 2002; Resource Information Unit, 2002). Prior to the onset of the wet season, MSL managed to carry out a limited drilling, mapping, and sampling program that included bulk samples for assay and metallurgical testing. According to the company, the feasibility plan and all fieldwork will be completed in 2003, followed by completion of engineering and flow-sheet design, with possibly a development decision in early 2004. Speewah is 140 kilometers (km) from the Port of Wyndham, which is already prepared to take product from a nickel/copper/cobalt project south of Speewah and can handle medium-sized vessels (Crossley, 2003a).

China.—Determining China's actual production of acid- and metallurgical-grade fluorspar has always been difficult owing to the lack of official Government data and the complex nature of the network of producers, processors, exporters, and consumers in China. Problems range from an unreliable breakdown of export data by grade to the lack of reliable information on domestic consumption levels, which may include more than 400,000 t/yr of sub-metallurgical-grade fluorspar for cement and glass manufacturing.

Chinese exports decreased for the second straight year to about 1.01 million metric tons. Despite exporting 100,000 t less in 2002 than in 2001, overall production is estimated to be about the same owing to rising domestic consumption, especially for HF and other fluorochemical derivatives. China's production of steel and aluminum, both significant markets for fluorspar, continue to increase, but information on consumption rates per ton of steel or aluminum was not available. Export license fees were about $53 per ton, which was similar to 2001.

There is a concern among large consumers of fluorspar (particularly in the United States and Japan) about China's export license system, especially now that China has joined the World Trade Organization (WTO). The United States raised questions about China's export policy at the WTO's Council for Trade in Goods meeting on November 22, 2002, questioning the parity between domestic and foreign customers. WTO rules establish a general prohibition against export restrictions, with only limited exceptions. China's position on the export licenses is that they fall under the exception regarding exhaustible natural resources, set forth in article XX of the 1994 General Agreement on Tariffs and Trade. However, that exception only allows export restrictions if they were made effective in conjunction with restrictions on domestic production or consumption. Japan also voiced concerns at the November meeting and asked for detailed information about the system and whether it complied with WTO rules (Crossley, 2003a).

India.—Preliminary 2002 data from the Indian Bureau of Mines for fluorspar production was about 54,500 t. This included 47,700 t of graded fluorspar (assumed to be metallurgical- and possibly sub-metallurgical-grade fluorspar) and 6,800 t of concentrates (Indian Bureau of Mines, 2003b§). Most domestically produced fluorspar is consumed for steel, cement, glass, and other nonchemical uses. Historically, a very high level of impurities, such as phosphates, has been a major constraint in developing fluorspar mines in India. Although production was reported from five mines, the largest producer is Gujarat Mining Development Corp. in Gujarat State, which is in western India and borders Pakistan and the Arabian Sea. India's fluorspar consumption is estimated to be about 140,000 t/yr, based on domestic production of 54,500 t and imports of 91,500 t (Indian Bureau of Mines, 2003a§). The four largest producers of HF and fluorochemicals, in descending order of capacity, were Tanfac Industries Ltd., Navin Fluorine, Gujarat Fluorine Corp., and SRF Ltd. Supply for these companies is met by imports, with the majority coming from China (Moorthy, 1997).

South Africa.—In 2001, South Africa produced 286,000 t of fluorspar, its highest fluorspar production level since 1990. In 2002, however, total production decreased to 227,000 t as a result of the shutdown of the Buffalo Fluorspar mine and poor operational performance at South African Land and Exploration Co.'s (Sallies) Witkop Fluorspar mine. The Buffalo mine shut down because of legal problems with the previous owners but hoped to resume production in 2003 (Ratlabala, 2003). Sallies has disappointed investors and reported a sharp deterioration in operational and financial results during the second half of 2002. As a result, majority stockholders in Australia replaced Sallies' management with turnaround specialists FRM Strategies in an attempt to save the company. The company initiated a turnaround strategy that involves an extensive exploration program, improved mine planning, and operational improvements. These improvements are focused on optimizing the upgrade of the flotation plant, completed in December, with the goal of accommodating a higher feed rate, increasing recoveries, and improving quality (Bailey, 2003§; Bain, 2003§). Profits of South African fluorspar companies slipped in 2002 because of the strength of South Africa's currency, the rand, which appreciated 40% against the U.S. dollar. Fluorspar contracts are negotiated in dollars, but when converted, a strong rand means a smaller return on the sale.

In October, the new Mineral and Petroleum Resources Development Act (MPRDA) was signed by President Mbeki; in the same month, South Africa's new mining empowerment charter was concluded. The conclusion of the MPRDA depended on the completion of a royalty bill, which was introduced in March 2003 in the form of the Mineral and Petroleum Royalty Bill. These three legislative vehicles compose the documentation intended to overhaul the financial and ownership structure of the South African mining industry by simplifying the process of application to prospect and mine, increasing the participation of historically disadvantaged South Africans, and recognizing that the country's natural resources should be used for the benefit of all citizens (Crossley, 2003b; Industrial Minerals, 2003b).

Vietnam.—In 2002, Tiberon Minerals Ltd. prepared a prefeasibility study on its Nui Phao tungsten-fluorite prospect, which is 80 km north of Hanoi. The results of the study were released in January 2003 and proposed a 16-year mine life for the project, which would produce 6,000 t/yr of tungsten trioxide, 196,000 t/yr of fluorspar (mostly acid grade), and lesser amounts of bismuth, copper, and gold. Fluorspar recovery would be as a byproduct of the tungsten recovery because, at about 8% to 10% CaF_2, the fluorspar ore grade is too low to be economically mined only for fluorspar. The project has two Vietnamese joint-venture partners (each with a 15% stake)—Thai Nguyen Mineral Co., which subleases the property to Tiberon and has helped develop and maintain a relationship with the Provincial Government, and General Export Import Company Hanoi Ltd., which is one of the first private companies in Vietnam to have been granted a license to import and export in its own right. Tiberon expects to take about a year to finalize its bankable feasibility study and to get financing in place, 18 months to construct mine and mill, and 3 to 6 months to start up. The company is looking at a startup date in early 2006 (Industrial Minerals, 2003a).

Outlook

Fluorocarbon production from HF is the single largest market that drives acid-grade fluorspar demand. In 2003, the ban on production and importation of the widely used blowing agent HCFC 141b will go into effect. The expected loss of market share to nonfluorocarbon replacements will be significant. Some sources estimate that fluorocarbons will lose one-half this market to not-in-kind replacements, such as carbon dioxide, water, and pentane isomers. Growth potential in the refrigerant market looks fairly positive for the next few years, and the fluoropolymer precursors market will continue to display solid growth. It is difficult to forecast how these mixed factors will affect fluorspar consumption. A factor to remember is that many of the replacement HFCs use more fluorspar than the CFCs or HCFCs they are replacing. Overall, the North American outlook for HF demand during the next several years is for slow growth of maybe 1% per year.

Worldwide aluminum consumption is expected to increase by 1% to 3% per year during the next few years, and consumption of AlF_3 should mirror this forecast. The strongest growth is expected in China and the Commonwealth of Independent States where the largest increases in aluminum production are expected and where there are high consumption rates because of the continued use of older smelters. The small increase in AlF_3 consumption is expected to be met by output from fluorspar rather than fluorosilicic acid.

In the United States, fluorspar sales to the steel industry should increase in 2003 or at least stabilize if the economy improves and if domestic steel production continues to be protected by the import tariffs. Smaller markets, such as ceramics and glass, should improve with the economy. The welding flux market also may improve in the short term, but in the long term will suffer from the shift to solid wire products from stick arc welding rods. Growth is expected in the cement market. This market has been growing in Mexico, Central America, and South America, and metspar suppliers are hoping to duplicate such growth in Canada and the United States.

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TABLE 1
SALIENT FLUORSPAR STATISTICS[1, 2]

		1998	1999	2000	2001	2002
United States:						
Exports[3]	metric tons	23,600	55,400	39,800	21,200	24,300
Value[4]	thousands	$3,890	$6,980	$5,330	$3,250	$3,540
Imports[3]	metric tons	503,000	478,000	523,000	522,000	494,000
Value[5]	thousands	$62,700	$56,900	$65,200	$69,000	$62,000
Value per ton, acid grade[5]		$128	$124	$128	$135	$128
Value per ton, metallurgical grade[5]		$89	$88	$84	$80	$89
Consumption, reported	metric tons	538,000	514,000	512,000	536,000	588,000
Consumption, apparent[6]	do.	591,000	615,000	601,000	543,000 [7]	477,000 [7]
Stocks, December 31:						
Consumer and distributor[8]	do.	468,000	373,000	289,000	221,000	245,000
Government stockpile	do.	243,000	146,000	112,000	112,000	109,000
World, production	do.	4,430,000 [r]	4,300,000 [r]	4,470,000 [r]	4,590,000 [r]	4,550,000 [e]

[e]Estimated. [r]Revised.
[1]Data are rounded to no more than three significant digits.
[2]Does not include fluorosilicic acid production or imports of hydrofluoric acid and cryolite.
[3]Source: U.S. Census Bureau; may be adjusted by the U.S. Geological Survey.
[4]Free alongside ship values at U.S. ports.
[5]Cost, insurance, and freight values at U.S. ports.
[6]Imports minus exports plus adjustments for Government and industry stock changes.
[7]Calculations made using only acid-grade stocks data from the three largest consumers.
[8]Includes fluorspar purchased from the National Defense Stockpile but still located at National Defense Stockpile depots.

TABLE 2
U.S. REPORTED CONSUMPTION OF FLUORSPAR, BY END USE[1]

(Metric tons)

End use or product	Containing more than 97% calcium fluoride		Containing not more than 97% calcium fluoride		Total	
	2001	2002	2001	2002	2001	2002
Hydrofluoric acid and aluminum fluoride	429,000	478,000	1,100	406	430,000	478,000
Metallurgical	21,300	22,500	43,700	54,400	65,000	76,900
Other[2]	23,700	33,300	17,000	--	40,700	33,300
Total	474,000	533,000	61,800	54,800	536,000	588,000
Stocks, consumer, December 31[3]	71,100	91,600	NA	30,900	NA	122,000

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes acid grade used in enamel, glass and fiberglass, steel castings, and welding rod coatings.

[3]Stocks data for 2001 were only available from hydrofluoric acid and aluminum fluoride consumers, while stocks for 2002 also include data from distributors.

TABLE 3
PRICES OF IMPORTED FLUORSPAR

(Dollars per metric ton)

Source-grade	2001	2002
Chinese, dry basis, cost, insurance, and freight (c.i.f.) Gulf port, acidspar filtercake	136-141	128-135
Mexican, free on board (f.o.b.) Mexico:		
Acidspar filtercake	105-125	105-125
Acidspar filtercake, arsenic <5 ppm	138-150	141-150
Mexican, c.i.f. port of U.S. entry, metspar[1]	82	87
South African, f.o.b. Durban	105-125	105-125

[1]Metspar prices are the average value per metric ton of imported Mexican metspar for the fourth quarter calculated from the U.S. Census Bureau statistics.

Sources: Industrial Minerals, no. 411, p. 82, December 2001, and no. 423, p. 70, December 2002.

TABLE 4
U.S. EXPORTS OF FLUORSPAR, BY COUNTRY[1]

	2001		2002	
Country	Quantity (metric tons)	Value[2]	Quantity (metric tons)	Value[2]
Canada	15,800	$2,410,000	18,600	$2,700,000
China	--	--	174	25,200
Dominican Republic	--	--	175	19,300
Mexico	3	2,510	95	25,600
Taiwan	5,020	733,000	5,130	741,000
Other[3]	374	101,000	125	29,700
Total	21,200	3,240,000	24,300	3,540,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Free alongside ship values at U.S. ports.

[3]Includes Belgium, Israel, Japan, Malaysia, the Republic of Korea, Saudi Arabia, the United Kingdom, and Venezuela.

Source: U.S. Census Bureau.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF FLUORSPAR, BY COUNTRY AND CUSTOMS DISTRICT[1]

Country and customs district	2001 Quantity (metric tons)	2001 Value[2] (thousands)	2002 Quantity (metric tons)	2002 Value[2] (thousands)
Containing more than 97% calcium fluoride (CaF_2):				
China:				
Houston, TX	174,000	$24,700	193,000	$25,600
New Orleans, LA	179,000	23,800	152,000	18,800
Total	353,000	48,500	344,000	44,400
France, Philadelphia, PA	322	110	139	52
Germany:				
New Orleans, LA	1	2	--	--
Philadelphia, PA	--	--	1	3
Savannah, GA	51	24	--	--
Total	52	26	1	3
Japan, Cleveland, OH	--	--	2,910	344
Mexico:				
Laredo, TX	22,600	3,190	22,300	3,190
New Orleans, LA	5,340	499	12,600	1,150
Total	27,900	3,690	34,900	4,340
South Africa:				
Houston, TX	45,600	6,010	--	--
New Orleans, LA	68,000	8,420	83,100	10,300
Total	114,000	14,400	83,100	10,300
United Kingdom:				
Houston, TX	1	3	--	--
Los Angeles, CA	172	22	276	34
New York City, NY	--	--	2	2
Total	173	24	278	36
Grand total	495,000	66,800	466,000	59,500
Containing not more than 97% calcium fluoride (CaF_2):				
Austria, Charleston, SC	--	--	128	11
Canada, Buffalo, NY	94	31	147	48
Japan, Cleveland, OH	500	67	--	--
Mexico:				
Buffalo, NY	--	--	73	8
Laredo, TX	1,490	89	1,310	129
New Orleans, LA	24,800	1,950	21,800	1,830
Total	26,300	2,040	23,200	1,970
South Africa, New Orleans, LA	--	--	5,000	492
United Kingdom, New York City, NY	9	17	74	9
Grand total	26,900	2,150	28,500	2,530
Total imports all grades	522,000	69,000	494,000	62,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

Source: U.S. Census Bureau; may be adjusted by the U.S. Geological Survey.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF HYDROFLUORIC ACID, BY COUNTRY[1]

	2001		2002	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Canada	26,300	$31,000	28,300	$34,200
China	114	84	267	169
France	111	108	106	103
Germany	342	543	485	763
India	14	4	--	--
Ireland	211	212	--	--
Italy	--	--	37	38
Japan	1,130	2,930	1,360	3,450
Korea, Republic of	63	248	84	319
Mexico	83,000	78,300	84,200	79,800
Netherlands	--	--	3	17
United Kingdom	147	146	96	91
Total	112,000	114,000	115,000	119,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

Source: U.S. Census Bureau; adjusted by the U.S. Geological Survey.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF CRYOLITE, BY COUNTRY[1]

Country	2001 Quantity (metric tons)	2001 Value[2] (thousands)	2002 Quantity (metric tons)	2002 Value[2] (thousands)
Australia	1,450	$841	653	$329
Canada	1,770	759	1,000	250
China	153	128	429	327
Denmark	78	109	394	674
Germany	2,460	2,510	1,680	1,310
Hungary	415	431	339	418
Italy	--	--	3,000	2,110
Japan	70	52	135	95
United Kingdom	250	420	111	162
Other[3]	104	89	202	136
Total	6,750	5,350	7,950	5,810

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Cost, insurance, and freight values at U.S. ports.
[3]Includes Belgium, Hong Kong, Israel, the Republic of Korea, Russia, Turkey, and Ukraine.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF ALUMINUM FLUORIDE, BY COUNTRY[1]

Country	2001 Quantity (metric tons)	2001 Value[2] (thousands)	2002 Quantity (metric tons)	2002 Value[2] (thousands)
Canada	6,150	$4,940	6,140	$4,880
Italy	5,280	3,900	5,600	3,960
Mexico	4,170	3,300	4,960	3,860
Norway	1,800	1,410	--	--
Other[3]	36	95	276	283
Total	17,400	13,600	17,000	13,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

[3]Includes Germany, Japan, Panama, Spain, and Sweden.

Source: U.S. Census Bureau.

TABLE 9

FLUORSPAR: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country and grade[3, 4]	1998	1999	2000	2001	2002e
Argentina	61,468	12,704	11,200 e	9,075 r	7,715 p
Brazil, marketable:					
Acid grade	61,024	38,209	30,131	31,263 r	31,300
Metallurgical grade	11,058	6,717	12,831 r	12,471 r	12,500
Total	72,082	44,926	42,962 r	43,734 r	43,800
China:[e]					
Acid grade	1,180,000	1,200,000	1,250,000	1,250,000	1,250,000
Metallurgical grade[5]	1,170,000	1,200,000	1,200,000	1,200,000	1,200,000
Total	2,350,000	2,400,000	2,450,000	2,450,000	2,450,000
Egypt[e]	140	500	500	500	500
France:[e]					
Acid and ceramic grades	80,000	82,000	80,000	90,000	90,000
Metallurgical grade	30,000	25,000	20,000	20,000	15,000
Total	110,000	107,000	100,000	110,000	105,000
Germany[e]	25,000	28,000	30,000	30,000	32,000
India:[6]					
Acid grade	11,338	48	220	3,253	6,799 p
Metallurgical grade	5,519 r	4,025 r	44,784 r	44,302 r	47,646 p
Total	16,857	4,073	45,004	47,555	54,445 p
Iran[7]	25,904	18,387	20,000 e	20,000 e	20,000
Italy:[e]					
Acid grade	92,000	95,000	50,000	30,000	30,000
Metallurgical grade	15,000	15,000	15,000	15,000	15,000
Total	107,000	110,000	65,000	45,000	45,000
Kenya, acid grade	60,854	93,602	100,102	118,850 r	98,007 [8]
Korea, North, metallurgical grade[e]	30,000	25,000	25,000	25,000	25,000
Kyrgyzstan	3,200 e	2,997	3,000 e	1,175	2,750
Mexico:[9]					
Acid grade	330,711	323,282	334,780	343,486 r	390,000
Metallurgical grade	267,331	233,829	300,450	275,982 r	260,000
Total	598,042	557,111	635,230	619,468 r	650,000
Mongolia:					
Acid grade	122,000	100,000	111,443	127,000 r	120,000
Other grades[10]	45,900	54,600	87,400	72,000 r	80,000
Total	167,900	154,600	198,843	199,000 r	200,000
Morocco, acid grade	105,000	83,100	76,991 r	96,500 r	96,400
Namibia, acid grade[11]	42,139 r	71,011 r	66,128 r	81,245 r	81,084 [8]
Pakistan, metallurgical grade	1,000 e	220	997	1,000 e	1,000
Romania, metallurgical grade[e]	15,000	15,000	15,000	15,000	15,000
Russia	120,000 e	153,800	187,600	190,000 e	200,000
South Africa:[12]					
Acid grade	222,000 e	203,280	201,737	272,844 r	215,650 [8]
Metallurgical grade	15,000	14,000	10,618	13,156 r	11,350 [8]
Total	237,000	217,280	212,355	286,000 r	227,000 [8]
Spain:[e]					
Acid grade	110,000	123,000	120,000	115,000	115,000
Metallurgical grade	10,000	10,000	15,000	15,000	15,000
Total	120,000	133,000	135,000	130,000	130,000
Tajikistan[e]	9,000	9,000	9,000	9,000	9,000
Thailand, metallurgical grade	3,743	13,005	4,745	3,020 r	7,000
Tunisia	1,190	520	--	--	--
Turkey, metallurgical grade	5,000 e	4,812	4,113	4,000 r	4,000
United Kingdom[e]	65,000	42,000	35,000	50,000	45,000
Uzbekistan[e]	80,000	--	--	--	--
Grand total	4,430,000 r	4,300,000 r	4,470,000 r	4,590,000 r	4,550,000

See footnotes at end of table.

TABLE 9--Continued

FLUORSPAR: WORLD PRODUCTION, BY COUNTRY[1, 2]

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]World totals, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 6, 2003.

[3]In addition to the countries listed, Bulgaria is believed to have produced fluorspar in the past, but production is not officially reported, and available information is inadequate for the formulation of reliable estimates of output levels.

[4]An effort has been made to subdivide production of all countries by grade (acid, ceramic, and metallurgical). Where this information is not available in official reports of the subject country, the data have been entered without qualifying notes.

[5]Includes submetallurgical-grade fluorspar used primarily in cement that may account for 33% to 50% of the quantity.

[6]Year beginning April 1 of that stated.

[7]Year beginning March 21 of that stated.

[8]Reported figure.

[9]Data are reported by Consejo de Recursos Minerales, but the production of submetallurgical and acid grades has been redistributed based on industry data.

[10]Principally submetallurgical-grade material.

[11]Data are in wet tons.

[12]Based on data from the South African Minerals Bureau; data show estimated proportions of acid-, ceramic-, and metallurgical-grade fluorspar within the reported totals.